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Conservation Assessment for the Merlin in the Black Hills National Forest, South Dakota and Wyoming

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INTRODUCTION

This document is the result of the Black Hills National Forest Land and Resource Management Plan being appealed after the Regional Forester approved it in 1997. Further actions were deemed necessary for the plan, which included the need for information on species viability, diversity of species and their populations in the Black Hills National Forest (BHNF). The goal of this document is to provide information about merlins that will assist the BHNF of South Dakota and Wyoming to maintain viable populations of this species'.

In assessing the viability of merlins in the BHNF, their biology and conservation status are discussed. The specific topics of this document include systematics, distribution and abundance, population trends, movement patterns, habitat characteristics, food habits, breeding biology, demography, community ecology, risk factors, response to habitat changes, a review of conservation practices, and additional information needs. An enviro-gram (Andrewartha and Birch 1984) of the merlin's ecological web linkages is also presented (Figure 1).

An attempt was made to base this document primarily on peer-reviewed literature with a focus on the population in the Black Hills. However, limited data is available on merlins in the Black Hills so this document also includes peer-reviewed literature from studies within the general region of the BHNF. An attempt was made to use information from areas as close to the BHNF as possible so that reasonable inferences could be made. It should be noted that as the distance increased between the Black Hills and the areas from which inferences were made, there is likely to be a large amount of uncertainty that accompanies these inferences. Additionally, information from non-peer-reviewed sources such as State, United States Forest Service (USFS), and U.S. Fish and Wildlife Service (FWS) reports was used to provide a more thorough understanding of the biology and status of the merlin population in the BHNF.

CURRENT MANAGEMENT SITUATION

Management Status

The FWS has not listed the merlin under the Endangered Species Act (ESA). The Wyoming Natural Diversity Database (Fertig and Beauvais 1999) and the South Dakota Natural Heritage Program (South Dakota Natural Heritage Database 2001) have both designated the merlin as "G5", meaning it is secure with respect to its rangewide status although the species may be rare in parts of its range, especially at the periphery. The USFS has designated the merlin as a "Sensitive Species" in Region 2, which includes the BHNF. A Sensitive Species classification means that it is a species whose numbers or habitat is declining and evidence indicates that it could be proposed for federal listing under ESA if action is not taken to reverse or stop the decline. The Wyoming Game and Fish designated the merlin as a "Species of Special Concern, Category III" (Oakleaf et al. 1996), meaning that populations are declining or restricted in numbers and/or distribution, but extirpation is not imminent, and habitat is restricted or vulnerable, but there is no recent or on-going significant loss. In Montana, the merlin is not given any special conservation status. In Nebraska, it is designated as "S1" which means they are critically imperiled because of extreme rarity or because some factor of a species life history makes it vulnerable to extinction (Nebraska Natural Heritage Database).

Existing Management Plans, Assessments, Or Conservation Strategies

The following are species assessments, management plans, or conservation strategies for the merlin.

- Armbruster, J. S., ed. 1983. Impacts of coal surface mining on 25 migratory bird species of high Federal interest. U.S. Fish and Wildlife Service, FWS/OBS-83/35. 348 pp.
- Ayers, L. W. and S. H. Anderson. 1999. Reoccupancy and Use of Historic Breeding Sites by Richardson's Merlin (*Falco columbarius richardsonii*) in Wyoming. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY.
- Becker, D. M. 1985. Reproductive Ecology and Habitat Utilization of Richardson's Merlins in Southeastern Montana. M.S. thesis, University of Montana. 62p.
- Doolittle, T. C. J. 1989. Status of the Eastern Taiga Merlin (*Falco c. columbarius*) in the Upper Midwest Region, 1989 Progress Report. Cable Natural History Museum, Cable, WI.
- Schempf, P. F. and K. Titus. 1988. Status of the Merlin (*Falco c. columbarius*) in interior Alaska, 1988 Progress Report. U.S. Fish and Wildlife Service, Juneau, AK.
- Sodhi, N. S., L. W. Oliphant, P. C. James, and I. G. Warkentin. 1993. Merlin (*Falco columbarius*). In the Birds of North America, No. 44 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Trimble, S. A. 1975. Merlin Falco *columbarius*. U.S.D.I., Bureau of Land Management. Habitat Management Series for Unique or Endangered Species. Report No. 15, Denver, CO.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics

Systematics of the merlin *are* described by Sodhi et al. (1993). There are three North American subspecies: the black merlin (*F. c. suckleyi*) from the Pacific Northwest, the taiga merlin (*F. c. columbarius*) of the boreal forest, and the Richardson's merlin (*F. c. richardsonii*), a pale colored form that breeds in northern prairies and aspen parkland. The Richardson's merlin is the subspecies common to the Black Hills, therefore, the primary emphasis of this document will be on this subspecies. Diagnostic characteristics of merlins are that they are sexually dimorphic in size and plumage. The average weight of males is 160-170 g and the average weight of females is 220-240 g. The dorsal plumage of adult males varies from blackish gray to pale blue-gray and the tail is black with generally 2-4 lighter (gray) bands and a white terminal band. Females have a dorsal plumage that is typically brownish, a dark brown tail with buffy to white light bands and a terminal white band. Yearlings of both sexes resemble adult females in coloration, but are darker on the back.

Distribution And Abundance

The distribution of merlins has been summarized by Sodhi et al. (1993). The worldwide distribution of the merlins during the breeding season is circumpolar in the Northern Hemisphere. Their distribution during the winter includes most of Europe, Iceland, Algeria,

Morocco, Egypt, Turkey, Iraq, Iran, India, China, Japan, Korea, and Vietnam, North America, Central American, and South America. The distribution of merlins in North America during the breeding season includes Alaska, most of Canada and parts of the northern and western United States. The winter range of merlins in North America is from southern Canada to the southern United States, south into Panama, the West Indies, the Caribbean islands, Central America, northern South America, Venezuela, Columbia, Ecuador, and northern Peru. Due to their ability to migrate long distances, there do not appear to be any isolated merlin populations.

Few estimates of local abundance are available for the Black Hills region. In the South Dakota Breeding Bird Atlas, breeding merlins are considered 'uncommon' and only occur in the western part of the state (Peterson 1995). Between 1988-1993, three breeding pairs were 'confirmed', the presence of another 11 breeding pairs was 'probable', the presence of another two breeding pairs was 'possible', and two other individual merlins were 'observed' but there was no evidence of breeding (Peterson 1995). In Wyoming, the merlin is classified as an uncommon year-round resident (Wyoming Game and Fish Department 1999). The results of a survey in Wyoming during the 1998 and 1999 nesting seasons suggested that merlins were confined to northeast Wyoming (Ayers and Anderson 1999). However, Ayers and Anderson (1999) noted that, "Wildlife Observation System (WOS) records, Wyoming Game and Fish Department (WGFD) data, recent anecdotal observations, and interaction with local biologists indicate otherwise." The survey did not estimate the relative abundance of merlins in Wyoming but it did determine that merlins are more abundant and persistent at historic sites than previously documented. Merlins breed in southeast (SE) Montana (Sieg and Becker 1990) and have also been observed there during the winter (Bergeron et al. 1992). Sieg and Becker (1990) found 44 active merlin nests in SE Montana during a three year study. Nebraska is considered the extreme southern border of breeding, with nesting reported only in NW Nebraska (Mollhoff, W.J. 2001). No estimates of local abundance are available in the BHNF.

Population Trend

Historically, environmental contaminants have had a major impact upon raptor populations in North America. Population declines of merlins and other raptors were attributed mostly to the extra mortality of adult birds caused by dieldrin and other cyclodienes (Newton et al. 1982). Additionally, use of other pesticides such as dichlorodephenyltrichloroethane (DDT) from the late 1940s through the early 1970s decreased merlin populations by causing eggshell thinning and decreased reproductive success (Duncan 1993). In SE Montana, eggshells collected from 1978 – 1981 showed reductions of 13% in shell weight and 20% in shell thickness indices when compared to eggshells collected before 1946 (Becker and Sieg 1987b). However, it appears that since many environmental contaminants were banned in the early 1970's, Richardson's merlin populations have been increasing (James 1987, Latta 1994). The North American Breeding Bird Survey (BBS) estimated a population increase of 13.3% per year (p<0.00001) between 1966 and 2000 (Sauer et al. 2001). Christmas Bird Counts (CBC) do not provide reliable estimates of population trend due to small sample size and the source of wintering birds is unknown (Sauer et al. 1996, Ayers and Anderson 1999). A population increase has been most apparent in certain urban centers of Canada (Duncan 1993). For example, a relatively large population was established in Saskatoon, Canada where they were previously uncommon. The breeding population grew from one pair in 1971 to 35 pairs in 1992 (Sodhi et al. 1992). Possible explanations for population increases in such urban centers includes an increase in nest

availability from the appearance of urban-nesting corvids which provided nests for the merlins, and an increase in prey availability in the form of Bohemian waxwings (*Bombycilla garrulus*) (Duncan 1993).

The increase in merlin numbers has not been documented throughout their entire range in North America though. During the fall, a steady decrease in numbers of migrating tiaga merlins past Cape May, New Jersey between mid-1980s to 1992 was documented (Sodhi et al. 1993). A simultaneous slide in numbers of other northeastern hawks suggests that the phenomenon may stem from an ecosystem-wide change or degradation, possibly acid rain (Sodhi et al. 1993).

No estimates of population trend are available for merlins in the Black Hills. However, Anderson and Ayers (1999) documented that nest reoccupancy was high and breeding success in northeast (NE) Wyoming was similar to other areas in the Northern Great Plains where merlin populations are growing (Sodhi et al. 1992, James et al. 1989). Of 10 nest sites in NE Wyoming where breeding attempts occurred in 1998, subsequent breeding attempts were noted at 9 sites in 1999. Breeding success was 80% in 1998 and 100% in 1999, with 2.9 and 3.6 fledglings/breeding attempt, respectively.

Broad-Scale Movement Patterns

Most Richardson's merlins migrate into the southcentral United States and northern Mexico for winter although urban populations have been described as partial migrants (Sodhi et al. 1993). Non-migratory merlins are common in some cities of Canada but are rare in rural areas (James et al. 1987). Merlins captured and banded in western Canada appear to migrate along the eastern front of the Rocky Mountains in the United States (Schmutz et al. 1991). Taiga merlins captured and banded along a migration route in New Jersey, migrated along the Atlantic Coast to winter ranges in Florida and the Greater Antilles (Clark 1985). Peak fall migration occurs during September and October (Clark 1985, Schmutz et al. 1991) while peak spring migration occurs during February through April (Sodhi et al. 1993). In the fall, females migrate before males but males migrate back to breeding grounds before females (Becker and Sieg 1985, Clark 1985).

Habitat Characteristics

Due to the vast geographical distribution and long migrations, merlins use a variety of different habitats. The breeding habitat of taiga merlins is usually in areas near forest openings, in fragmented woodlots, and often near rivers, lakes or bogs of the boreal forest (Sodhi et al. 1993). Black merlins from the Pacific Northwest generally nest in coastal areas and along rivers (Sodhi et al. 1993). The habitat of Richardson's merlins, which is the most common subspecies to nest and winter in the BHNF, is described below.

The characteristics of merlin nest stands in southeast (SE) Montana have been described by Becker and Sieg (1985) and Sieg and Becker (1990). A key feature is the nest itself since merlins do not actually build their own nests. Nearly all merlin nests were originally black-billed magpie (*Pica pica*) nests placed in ponderosa pines (*Pinus ponderosa*). Merlins displayed a tendency to select nest sites that combined the attributes of easy access with maximum concealment of the nest. In a comparison of utilized and non-utilized nest sites, utilized nest sites had larger maximum height of trees adjacent to nest trees, lower total basal area of the nest site, smaller DBH of the nest tree, less steep slopes, and selection for nests with south aspects. Additionally, more utilized nests were covered with a stick canopy, total tree density was lower,

ground cover was higher, and overstory closure was lower at utilized nest sites. Based on the results of logistic regression, maximum tree heights adjacent to the nest and total basal area, were most useful in discriminating between utilized and nonutilized nest sites. The forested areas where nests are located are used mainly for the function of nesting as little hunting actually occurs there.

Similar habitat selection is likely to occur by merlins in the BHNF (Figure 2). Sieg and Becker (1990) commented, "We have observed merlins nesting in similar ponderosa pine habitats in Montana, eastern Wyoming, the western Dakotas, and western Nebraska. Although local differences in nesting habitat may occur between these areas, the factors identified in this study appeared to be present at these areas as well." Ayers and Anderson (1999) also commented on the similarity of habitat conditions in the region, "Not surprisingly, merlins in Wyoming used similar microsite habitats as in southeastern Montana." Nest sites in Wyoming had an average basal area = $4.7 \pm 2.9 \text{ m}^2$, nest tree height = $12.1 \pm 3.9 \text{ m}$, nest tree dbh = $0.3 \pm 0.09 \text{ m}$, nest height = $9.0 \pm 3.11 \text{ m}$, and slope = 16 degrees. Several subtle differences were noted though. Nest sites in Wyoming tended to be at slightly higher elevation (1335 m) and had a propensity toward northeast slopes, whereas nest sites in SE Montana had a lower average elevation (1180 m) and selected for southern exposures. Understory cover was also significantly less in Wyoming (11%) vs. Montana (approx. 55%) and was likely related to the site aspect differences. Also, only 60% of merlin nests were in domed magpie structures in Wyoming compared to 100% in SE Montana.

Nesting merlins in the grasslands of Alberta and Saskatchewan have been associated with deciduous stands near rivers and streams and with natural or planted shelterbelts (Fox 1964, Hodson 1976, Houston and Schmidt 1981).

Males are the primary food providers for the family unit during the nesting season (Sodhi et al. 1993). Therefore, most of the information on habitat use during the breeding season, not including the nest stand, is from studies on the movements of males. Habitat use by breeding male merlins in SE Montana has been described by Becker and Sieg (1987a). Three males had an average home range size 21.3 km². Each home range encompassed five habitats. Sagebrush/grassland, riparian, and ponderosa pine communities were used significantly more, while grasslands and agricultural fields were used less than expected, based on the proportions in the combined home range. Male merlins in SE Montana displayed a preference for patchy shrub/grasslands as hunting habitats. The preference of this habitat type for hunting may be due to elevated perches provided by big sagebrush (*Artemisia* sp.) interspersed with grassland which attracts high densities of horned larks (*Eremophila alpestris*) and vesper sparrows (*Pooecetes gramineus*).

Merlins have been increasingly colonizing urban areas as a function of increased nest and prey availability (Oliphant and Haug 1985, James et al. 1987). Several differences are noted when comparing urban and rural nest sites. In urban areas, merlins nest in coniferous trees as compared to deciduous trees. They also use crow (*Corvus brachyrhynchos*) nests instead of black-billed magpie nests (Warkentin and James 1988). All crow nests used by nesting merlins had open canopies whereas all black-billed magpie nests used had stick canopies. It is likely the changes in tree-type and nest-type between rural areas to urban areas are a function of nest availability and ability to conceal nest sites from potential predators such as crows and great horned owls (*Bubo virginianus*) (Warkentin and James 1988). Sodhi and Oliphant (1992)

described how resident merlins in urban Saskatoon, Saskatchewan displayed different habitat use characteristics compared to immigrant merlins. The hunting ranges of resident males was only $6.3 \pm 1.3 \text{ km}^2$ compared to $33.7 \pm 12.1 \text{ km}^2$ for immigrant males. Additionally, immigrant males spent more time hunting outside of the city than resident males, possibly because immigrants had prior experience with out-of-city habitats during the breeding season. Similar to merlins in rural environments, birds that hunted both within and outside the city generally avoided agricultural habitat, which is possibly because this habitat had lower prey abundance than other habitat types. However, urban merlins selected the urban, parks, and grassland habitats which differs from rural merlins.

One of the few studies that has documented habitat selection of merlins at the landscape scale was by Ayers and Anderson (1999) in NE Wyoming. The most obvious difference between occupied and random nest sites was that the ponderosa pine cover type occurred on 62-65% of occupied sites and only 10% of random sites. Coverage of ponderosa pine on occupied sites was 39%, while random sites had a nominal 7% cover. Mixed grass prairie and mixed grass cover was also higher at use plots than at random plots, 53-62% vs. 27% and 22-31% vs. 14%, respectively. Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) cover type was present in 35-39% of merlin sites with a coverage of 12-18% while it was present in 75% of random sites with a coverage of 12-18%. Ultimately though, they concluded, "We were unable to identify any unique variables that would reliably identify merlin breeding habitat in Wyoming. Merlins did not appear highly selective or 'narrow' in their habitat use at nest sites."

Food Habits

Merlins are opportunistic hunters, which take prey according to relative abundances (Sodhi et al. 1993, Sodhi and Oliphant 1993). Prairie avifaunas are the dominant class of prey in the merlins diet during the breeding season but their diet also includes a small proportion of mammals, insects, and reptiles (Becker 1985b, Hodson 1976, Sodhi and Oliphant 1993). Most studies report specialization on one or two locally abundant species of small birds in the 20-40 g weight range that often forages away from cover (Sodhi et al. 1993).

Attacks are usually initiated from a perched position (Sodhi et al. 1993). Hunting success is higher in the *breeding* season (28%) than in the winter (11%) which is likely because of higher prey vulnerability due to the influx of fledgling prey available during the breeding season (Sodhi et al. 1993).

Prev Species

No studies on the diet of merlins in the BHNF have been conducted. However, in SE Montana, Becker (1985b) documented that the diet of breeding merlins was mainly birds. Ninety-two percent of the prey items and 93% of the prey biomass was birds. A total of 32 prey species were identified as from which 28 species were birds. Seventeen of the 28 (61%) were typically associated with grasslands or predominantly open prairie habitats. Horned larks, lark buntings (*Calamospiza melanocorys*), vesper sparrows and meadowlarks (*Sturnella neglecta*) comprised 21%, 21%, 10%, and 12% of the total prey biomass, respectively. Seven avian species (7%) which represented 10% of the total prey biomass were associated with forested habitat. Grasshoppers (*Acrididae* spp.) and moths (*Noctuidae* spp.) were the only insects recorded as prey and they represented 5% of the total number of prey. Mammals, mostly thirteen-lined

ground squirrels (*Spermophilus tridecemlineatus*), accounted for approximately 3% of the total number of prey and 6% of prey biomass. Due to the similarity of the study area in SE Montana to the adjacent region, the diet of merlins in the BHNF is presumed to be similar (Ayers and Anderson 1999, Sieg and Becker 1990).

In the urban environment of Saskatoon, Saskatchewan, over 99% of prey were birds, with the remainder being mammals (Sodhi and Oliphant 1993). House sparrows (*Passer domesticus*) were the principal prey and horned larks were the second most common prey.

The winter range and winter diet of merlins is poorly documented (Sodhi et al. 1993). Urban wintering merlins mainly feed on house sparrows and Bohemian waxwings (Warkentin and Oliphant 1990).

Characteristics Of Prey Species

The literature (Becker 1985a, Becker 1985b), suggests that horned larks and lark buntings are the most important prey species of merlins in the BHNF. Therefore a brief discussion of each species characteristics and key habitat components is presented below.

Horned larks are a common, widespread bird of the open country that prefers short, sparsely vegetated prairies, deserts, and agricultural lands, and generally avoids forested areas (Beason 1995). In Wyoming, nesting birds averaged 2 to 3 successful broods/season, clutch sizes varied from 2 to 5 eggs, and nest success was relatively high at 53% (Verbeek 1967 in Beason 1995). Horned larks are most abundant in the High Plains and the population trend has been essentially flat over the past 30 years for this region (Beason 1995, Sauer et al. 2001). Due to the high recruitment and stable population trend of horned larks, it is unlikely that merlin populations in the BHNF are limited by this prey species.

Lark buntings are neotropical migrants, which breed mostly in short-grass prairies and on sagebrush plains with an understory of grass and weeds (Gough et al. 1998). They average 2 broods and typically lay 4-5 eggs (Gough et al. 1998). In South Dakota and Wyoming, the population trend is negative which is likely due to habitat loss (Sauer et al. 2001). It is possible that the negative population trend for lark buntings could be a limiting factor to merlin populations in the BHNF.

Breeding Biology

Phenology Of Courtship And Breeding

The phenology of courtship and breeding of merlins in SE Montana has been studied by Becker (1985a). Breeding activity spanned 5 months from the earliest observation of adults to the latest dispersal of adults and young from nesting areas. First arrival at the nest stand occurred between 11 March and 23 April. Courtship rituals occurred between 5 April and 26 May. Egg laying occurred between 15 April and 7 June. The incubation period occurred between 15 April and 27 June. Females usually incubated eggs. The hatching period occurred between 24 May and 27 June. Brooding occurred between 24 May and 4 July. The nestling period occurred between 24 May and 26 July. The fledging period occurred between 24 June and 18 July. Young merlins fledged 26 – 33 days after hatching. Fledglings remained in the vicinity of the nest from 7 – 19 days after fledging. Dispersal occurred between 10 July and 9 August. The chronology of

merlin breeding activities in SE Montana was similar to that of merlins in Saskatchewan, Canada (Sodhi et al. 1992).

Courtship Characteristics

Feldsine and Oliphant (1985) have documented characteristics of merlin courtship. The first signs of activity around potential nest sites are the spectacular courtship flights of males. Several types of flight have been described which include power flying, power diving, rocking glide, flutter flight, high circling/soaring, and a slow landing display. Additional courtship interactions include food begging by the female, food transfers by the male to the female, and nest displays in which both sexes enter the potential nest and make *tic* vocalizations. Prior to copulation, the male may bow, fan his tail, and stare intently at the female while uttering copulation chutters. Females may solicit copulation by bowing and fanning her tail.

Nest Characteristics

Becker (1985b) described nest characteristics of breeding merlins in SE Montana. Nesting habitat consisted primarily of mixed-age ponderosa pine stands of low-to-moderate density. These stands were located almost exclusively on the sideslopes of buttes and hills, and they were generally dominated by a few pines of greater age, diameter, and height. Merlins selected old nests of black-billed magpies located in these trees. Canopy-covered nests located less than 2 m from the top of the tree were favored by breeding merlins.

Clutch Initiation And Size

In SE Montana, egg laying occurred between 15 April and 7 June (Becker and Sieg 1985). The average clutch size at active nests was 4.3 ± 0.8 (Becker and Sieg 1985).

Parental Care

Parental care by breeding merlins has been described by Sodhi et al. (1992). Females usually incubated eggs. Females were also responsible for brooding, which only occurred until nestlings were up to 7 days old. Males delivered most of the food and were most active in nest defense against corvids.

Site And Mate Fidelity

Site and mate fidelity of urban-breeding merlins has been described by Warkentin et al. (1991). Merlins have low (20%, n=60) annual mate fidelity, which is apparently related to site fidelity. Mates were the same 40% (n = 25) and 5.7% (n = 35) of the time at the same and different nesting sites, respectively.

Differences in site fidelity between male and female merlins occurs and Wiklund (1996) presented several trends associated with the differences. Fidelity to breeding areas is higher in males than females, and females dispersed nearly three times as far as males did between breeding seasons. Males breeding at high density disperse shorter distances than other males. Dispersal distance of females is related to aspects of the mate. Females that mate with older males and with males that survive to the next season make shorter movements than other females. Additionally, low reproductive success is associated with long adult dispersal the following year.

Demography

Life History Characteristics

Most estimates of merlin vital rates are limited to urban populations. Many individuals have a relatively short life span in which the maximum seldom exceeds eight years (Sodhi et al. 1993). The mean survival rate of adult breeding merlins in urban Canada was 0.62 ± 0.11 per year and there was no overall difference between males and females (Lieske et al. 2000). The overall juvenile survival rates were 0.23 ± 0.032 for males and 0.055 ± 0.012 for females (Lieske et al. 2000).

Anderson and Ayers (1999) documented the breeding success and recruitment rates of nesting merlins in NE Wyoming. Breeding success was 80% in 1998 and 100% in 1999, with 2.9 and 3.6 fledglings/breeding attempt, respectively. The breeding success in NE Wyoming is similar to other areas in the Northern Great Plains where merlin populations are growing (Sodhi et al. 1992, James et al. 1989). Age at first reproduction has been studied for urban merlins in Canada (Lieske et al. 1997). For males, 27% bred for the first time at age one, 56% at age two, 15% at age three, and 2% at age four. On average, male merlins entered the breeding population at 1.9 ± 0.7 years of age. For females, 80% were recorded breeding for the first time at age one, 15% at age two, and 5% at age three. On average, female merlins entered the breeding population at 1.3 ± 0.6 years of age.

Survival And Reproduction

Merlin populations suffered their largest documented declines between the late 1940s and the 1970s. The decline was caused by the use of pesticides such as dieldrin and DDT, which decreased adult survival and reproductive success (Newton et al. 1982, Duncan 1993). In SE Montana, eggshells collected from 1978 – 1981 showed reductions of 13% in shell weight and 20% in shell thickness indices when compared to eggshells collected before 1946 (Becker and Sieg 1987b). However, since harmful pesticides were banned in the 1970s, merlin populations have been increasing throughout most of North America except for migration routes along the East Coast. A steady decreasing trend occurred in the numbers of migrating tiaga merlins during the fall past Cape May, New Jersey from the mid-1980s to 1992 (Sodhi et al. 1993). A simultaneous slide in numbers of other northeastern hawks suggests that the phenomenon may stem from an ecosystem-wide change or degradation, possibly acid rain (Sodhi et al. 1993). Environmental contaminants clearly have the capability to adversely affect merlin survivorship.

Lieske et al. (2000) studied population demographics of urban merlins in Canada. Density-dependence regulated merlin population size by declines to survival of adults. James et al. (1989) documented the presumed causes of mortality to merlins in Saskatoon. Collisions (43%), shooting (7%), poison (2%), cat predation (2%), weather (1%), and unknown (45%) were reported as the causes of mortality for 88 merlins. No information is available on survivorship of merlins in the BHNF.

Lieske et al. (1997) commented about the ecological influences on reproduction of merlins. Female merlins begin breeding at an earlier age than male merlins. Older males are presumed to be competitively superior to yearlings with respect to defense of a territory, attracting mates, and provisioning food. Thus one of the main factors limiting the number of breeding pairs, and thus reproduction, might be the number of male territory holders.

Petty et al. (1995) studied the influence of prey density in forested areas upon reproductive success. A four-fold change in forest songbird density between two years had no effect on merlin breeding numbers or performance, which suggests that forest songbird densities do no effect reproductive success. These results are expected as merlins specialized on prairie avifaunas.

Social Pattern For Spacing

Becker and Sieg (1987a) documented the home range size of male merlins in SE Montana. The mean home range size of radio-tagged males (n = 3) during the nestling period was 23.3 ± 4.6 km². The maximum distance traveled from nests were 8 to 9 km. The home range of each bird overlapped with that of at least one of the other males. Also, the nest site of one male was located within the home range of another male.

Home range characteristics of urban breeding merlins have also been documented in Saskatoon, Canada (Sodhi and Oliphant 1992, Sodhi 1991 and 1993). Both males and females had smaller ranges in rich prey areas. Males increased the size of their hunting range from the nestling phase to the fledging phase, which has been hypothesized to occur because of (1) intersexual competition as females also hunt during the fledging period and/or (2) a decline in prey abundance on ranges. Spatial overlap in hunting ranges between neighboring merlins ranged from 0 to 77.3% suggesting that merlins might not defend hunting ranges for exclusive use. Additionally, merlin nest density does not explain the variation in hunting range size, which also suggests hunting ranges might not be defended for exclusive use. However, defense of nest sites has been observed during the breeding season as intraspecific nest intruders were aggressively chased off (Sodhi 1991).

Local Density Estimates

No estimates are available of merlin densities in the BHNF. In nearby SE Montana, Becker and Sieg (1985) estimated the breeding density at 3.8 pairs/100 km². In Saskatoon, Canada the breeding population was 25.4pairs/100 km², which is the highest documented density of this species, recorded (Sodhi 1991). Differences in densities in different areas may be related to availability of nesting sites during the breeding season and prey abundance (Sodhi et al. 1993)

Limiting Factors

The main factor mentioned in the literature thought to limit merlin populations today is nest availability (Sieg and Becker 1990). Merlins rely on other birds to create nests, which are eventually used by merlins. In SE Montana, merlins nest almost exclusively in black-billed magpie nests. This could be a limiting factor for merlins as both the BBS and CBC report negative trends for black-billed magpies over the past 30 years (Sauer et al. 1996, Sauer et al. 2001).

Food may also limit merlin populations. As prairie habitat is converted for agricultural uses, the diversity and abundance of prey species decreases. Merlins in SE Montana avoid agricultural landscapes when hunting (Becker and Sieg 1987a).

Historically, environmental contamination from pesticides has been the greatest limiting factor to merlin and other raptor populations. In the early 1970s, use of harmful pesticides was banned in

North America and the result has been the recovery of merlin populations.

Patterns Of Dispersal

Information on natal and adult dispersal of merlins is limited. James et al. (1987) documented the natal and adult dispersal of urban merlins in Canada. Adult dispersal of males and females was 1.1 ± 0.9 km and 2.3 ± 1.8 km, respectively. More males than females return to breed in natal areas with females generally travelling greater distances. Four young females were documented moving as far away as 71 - 259 km from their natal sites. Mean natal dispersal distance was 4.1 ± 2.9 km and 3.0 ± 1.4 km for males and females, respectively.

Wiklund (1996) documented several characteristics of adult dispersal of merlins in Sweden. Like merlins in urban Canada, male merlins displayed a stronger fidelity to breeding areas than females, and females dispersed further (~ 3x's) than males did between breeding seasons. Differences in male dispersal were correlated with breeding density. Males breeding at high density dispersed shorter distances than other males. Differences in female dispersal were correlated with aspects of the mate. Females that mated with older males, and with males, that survived to the next season, made shorter movements than other females. Additionally, low reproductive success was associated with long adult dispersal the following year.

Community Ecology

Predators And Relation To Habitat Use

Predation in this document is considered killing for food (Taylor 1984). Predation of merlins in North America is thought to be relatively low (Sodhi et al. 1993). James et al. (1989) estimated that predation only accounted for 2% of merlin mortality in Saskatoon, Canada but 45% of the cases were classified as unknown. Predation by cats, American crows, peregrine falcons (*Falco peregrinus*), great horned owls, Cooper's hawks (*A. cooperii*), prairie falcons (*Falco mexicanus*), golden eagles (*Aquilia chrysaetos*), and red-tailed hawks (*Buteo jamaicensis*) have been documented on merlin nests and/or adults (D. Becker pers.comm., Hodson 1976, Palmer 1988 in Sodhi et al. 1993).

The differences in nest site selection between urban and rural merlins are likely due to predator avoidance. Urban merlins use open crow nests in coniferous trees while rural merlins use closed black-billed magpie nests in deciduous trees (Warkentin and James 1988). It is likely the change in tree-type and nest-type from rural to urban areas is a function of nest availability and ability to conceal nest sites from potential predators such as crows and great-horned owls (Warkentin and James 1988).

No studies have been performed on predators and the relationship to habitat use for merlins in the BHNF.

Competitors

Competition is considered the "...negative effects which one organism has upon another by consuming, or controlling access to, a resource that is limited in availability" (Keddy 1989). Interspecific and intraspecific competition are the two forms of competition discussed here.

Interspecific competition occurs between organisms that are different species and intraspecific competition occurs between organisms of the same species.

Interspecific competition with merlins has been summarized by Sodhi et al. (1993). Merlins have been observed to mob great horned owls. Tree swallows (*Tachycineta bicolor*) and Brewer's blackbirds (*Euphagus cyanocephalus*) have been observed mobbing merlins. Aerial conflicts have been observed between hunting merlins and hunting carrion crows (*Corvus corone*) and hen harriers (*Circus cyaneus*) in Scotland (Dickson 1988 in Sodhi et al. 1993). In Sweden, fieldfares (*Turdus pilaris*) nesting close to merlin nests have higher reproductive success than those nesting further away (Wiklund 1982 in Sodhi et al. 1993), apparently because merlin presence deters other potential nest predators such as the hooded crow (*C. cornix*).

Intraspecific competition has also been summarized by Sodhi et al. (1993). Other merlins, intruding at a nest, are typically chased from the nest area. A yearling female has been observed chasing a yearling male to the ground and stole a partially plucked house sparrow from it. Merlins have also been observed locking claws with each other, which is probably in nest defense.

Parasites, Disease, And Mutualistic Interactions

Diseases and body parasites of merlins have been summarized by Sodhi et al. (1993). Trichomoniasis, septicaemia, coccidiosis, aspergillosis, fatty liver-kidney syndrome, and encephalitis are diseases that have been documented to rarely cause mortality of young and adults. No information is available on how the relationship between the above diseases and merlin susceptibility varies in different habitat types. Body parasites of young and adults include screw-worm flies, louse flies, chewing bird lice, and simulium flies. The frequency of body parasitism is unknown. No information is available on how the relationship between parasite infestation and merlin susceptibility varies in different habitat types. No information is available specific to the Black Hill about parasites, diseases, or mutualistic interactions involving merlins.

Risk Factors

Historically, environmental contaminants have had a significant negative impact upon merlin populations. Declines to raptor populations were attributed to the mortality of adult birds caused by dieldrin and other cyclodienes (Newton et al. 1982) and the use of other pesticides such as DDT, which caused eggshell thinning and decreased reproductive success (Duncan 1993). It appears that since many environmental contaminants were banned in North America in the early 1970s, Richardson's merlin populations have been increasing (James 1987, Latta 1994, Sauer et al. 2001). However, there is still a need for concern as these pesticides are still used in parts of the merlins winter range south of the United States.

Habitat degradation through the conversion of prairies for agriculture is presumably the most eminent risk factor to merlins in the Black Hills. Becker and Sieg (1987a) documented the importance of prairie landscapes for hunting. Merlins avoided agricultural landscapes when hunting, which is likely due to lower prey species richness, density, and species diversity. Loss of prairie landscapes to agriculture likely results in lower hunting success and thus, lower nest success. In the BHNF, grasslands are an uncommon habitat type as most of the area is forested with ponderosa pine. Obviously, grasslands are important to merlins as this is where hunting activities occur and constitute the largest amount of a habitat type in merlin home ranges.

Decreased nest availability by the loss of nest stands to timber harvest is another risk factor to merlins. Ponderosa pine is an important tree species for merlins in the Black Hills as it is the predominant tree used for nesting. Nests are usually placed in stands of mixed-age ponderosa pine of low-to-moderate density in which the height of adjacent trees to the nest tree was higher than on non-utilized sites. Ayers and Anderson (1999) documented that nest reoccupancy was high at sites were nesting had previously been observed. Loss of ponderosa pine stands with these attributes would presumably result in a decrease of suitable nesting habitat and decreased recruitment.

Merlin Responses To Habitat Change

Management Activities

Timber Harvest

In different areas and under different intensities, timber harvest could have both detrimental and beneficial effects to merlin populations in the BHNF. Many different forms and intensities of timber harvest have been proposed by the BHNF (BHNF 1996). The following levels of timber harvest are proposed under Alternative G, the preferred alternative. An estimated 5,400 acres/year over the next ten years was projected for precommercial thinning. A total of 25,500 acres/year for the next 10 years is the goal for commercial harvesting. Several different forms of commercial harvest will occur but the two main forms are shelterwood seed cuts (15,600 acres/year) and overstory removal harvest (6,100 acres/year), which combine for 85% of all commercial harvest.

Precommercial thinning occurs in stands too small in diameter to be sold for wood products. Dense stands of small diameter trees have not been documented as an important habitat of merlins. Therefore, it is not likely that precommercial thinning operations in these stands would negatively affect merlins. However, this form of harvest could negatively impact merlins if the operations occur in areas adjacent to nest stands during the nesting season. Over the long term though, precommercial thinning might be beneficial by producing suitable conditions for merlin nesting, decreasing fuel loads and thereby decreasing the likelihood of high-intensity crown fires.

The objective of shelterwood seed cuts, the primary form of harvest, is to cut all the trees except those needed to produce seed to regenerate the stand and to meet future stand dead requirements. Merlins in nearby SE Montana nested in stands that resembled this description (D. Becker pers.comm.). Nests were placed in mixed-age ponderosa pine stands of low-to-moderate density that were generally dominated by a few pines of greater age, diameter, and height (Becker 1985b). Therefore, shelterwood cuts could benefit merlins by creating ideal nesting habitat. The objective of overstory removal harvest, the second most common form of harvest, is to remove the remaining trees that were left to seed the area from the previous seed cut. This form of harvest could negatively affect merlins if trees used for nesting were removed.

The BHNF (1996) summarized the plausible negative effects of timber production. Merlins in this region nest predominantly in pockets of ponderosa pine adjacent to grasslands. Currently, there are 130,390 acres of forest lands that meet this requirement. Conversion of mature pine by timber harvest along meadow/prairie edges to younger, smaller structure could reduce the amount of suitable nesting habitat. However, timber harvest of mature pine might also be

viewed as beneficial if it reduced encroachment of pines into meadows and grasslands. Additional negative effects of timber harvest are that individuals could be stressed, displaced, or harmed during logging operations during the nesting season. Outside of the nesting season, the primary threat of timber harvest to merlins is the loss of habitat.

Recreation

The BHNF (1996) measures recreation through both dispersed and developed recreation. The estimated demand over the next ten years for dispersed recreation is approximately a half of the BHNF dispersed recreation capacity. Over the next 10 years, the BHNF is projected to construct an estimated 138 miles of new roads and 22 recreation sites for developed recreation. There are no positive benefits of recreation to merlins that we are aware of. The possible negitive impacts caused by recreation include habitat loss and stress to nesting pairs resulting in nest abandonment, especially if developed sites were place near active nest sites.

Livestock Grazing

Eighty-four percent of BHNF lands are suitable for livestock grazing and browsing. Grazing would not directly effect merlins, but indirectly could influence the small bird prey base (BHNF 1996). Most of their prey nest on the ground in grassland habitats. If insufficient cover remains, these prey populations could decline. Ideally, a mosaic of grazing intensities would occur across the landscape to provide a diversity of habitats for merlin prey species (Becker 1985b).

Mining

Effects of ground disturbance from mining could have variable levels of impacts to the merlin and their prey depending on the extent and intensity of the disturbance. With respect to oil and gas development, there are no producing wells within the BHNF (BHNF 1996). Only two exploratory wells are expected in the next 15 years on the BHNF and no discovery is expected so impacts to local merlin populations would be negligible. If higher levels of resource extraction do occur though, merlins could be adversely affected by the loss of nesting and/or hunting habitat (Becker 1985b).

Prescribed Fire

On the BHNF, 5,600 - 8,000 acres are projected to be burned annually by prescribed fires (BHNF 1996). Fire is a natural process in prairie communities. It is likely that merlins will benefit from prescribed fires on grasslands and in ponderosa pine forests. Prescribed fires control the extent of conifers in areas where they are likely to invade adjacent grasslands, and reduce the density of understory conifers in forests.

Fire Suppression

Perhaps the most subtle but far-reaching human effect on the Black Hills has been fire suppression (Knight 1994). Suppression has been a guiding principal for land management in the BHNF. Ponderosa pine forests are characterized by surface fires every five to twenty-five years. Burning kills most young trees but usually not the older trees, because of their thick bark, and it also maintains a more open forest with low amounts of fuel. Results of fire suppression include an increase in tree density, invasion of trees into adjacent grasslands, an increased likelihood of crown fires, and an increased likelihood of invasion by exotic species. Increased

tree density interferes with the merlins ability to fly there and limits visibility, which were thought to be important characteristics of nest sites in SE Montana. Invasion of trees into adjacent grasslands decreases the amount of hunting habitat available to merlins and grasslands are likely a limiting factor of merlins on the BHNF. Finally, high-intensity crown fires could result in vast stand replacing disturbances with a significant loss of nesting habitat.

Conversely, there is a theory that fire suppression has benefited merlins by allowing more nesting habitat to grow. In looking at old (70 - 100 years old) photos and comparing them with modern photos of Montana, Wyoming, and South Dakota, the newer photos seem to indicate better merlin nesting habitat than the older ones (D. Becker pers.comm.).

Non-Native Plant Establishment And Control

The establishment of some non-native plants has benefited merlin populations in urban parts of Canada (Warkentin and Oliphant 1990). First, ornamental trees attracted crows to nest in the urban areas and the crow nests eventually provided nesting structures for merlins. Also, ornamental fruit trees such as crabapple (*Malus* sp.) and mountain ash (*Sorbus* sp.) provided a winter food source for the Bohemian waxwing, a prey item of merlins, whose numbers have been increasing. These observations suggest that merlins can adapt to some non-native plants if appropriate nesting structures and food are available.

Cheatgrass (*Bromus* sp.) could be a problem for the merlin and their prey in the grasslands of the BHNF. The impacts of cheatgrass have been reported by Knight (1994). Cheatgrass leads to the rapid accumulation of a highly flammable fuel, shortening the fire-free interval. Fires occur more frequently, thereby diminishing the chances of sagebrush reestablishment, causing a decline in some perennial grass species, and favoring cheatgrass expansion still further. The ultimate result is a loss in the heterogeneity of the landscape, and probably lowered prey diversity, prey abundance, and prey availability for merlins. The invasion of this species can be hastened by the burning of areas adjacent to cheatgrass and also by livestock grazing.

Fuelwood Harvest

Fuelwood harvest in the BHNF occurs by individuals that search out dead and down material to cut up for their personal use while in the Forest. It is possible that fuelwood harvest could adversely affect merlins if snags that are used as perch sites are removed.

Natural Disturbance

Insect Epidemics

Knight (1994) summarized the effects of insects such as the mountain pine beetle (*Dendroctonus ponderosae*) on pine forests. Ponderosa pine, the most common tree species in the BHNF and the main tree species used by nesting merlins in this area, is subject to outbreaks of the mountain pine beetle. When populations of this beetle grow to large numbers, they are capable of killing many trees. Most of the mortality occurs to the large trees. Smaller trees and saplings usually survive. The typically homogeneous, even-aged structure of the pine forest is thereby converted to a more heterogeneous, uneven-age forest and succession is accelerated. Merlin nest sites show characteristics of heterogeneous, uneven-aged stands. Thus, nest sites could be lost to tree mortality in the short term. However, it is likely that endemic disturbances caused by the

mountain pine beetle would benefit merlins over the long term by creating stands ideal for nesting.

In Wyoming, the insects that most commonly cause disturbance on the lowlands are grasshoppers (Knight 1994). During outbreaks, grasshoppers decrease the amount of standing vegetation on the prairies, which could temporarily effect prey species such as horned larks, lark buntings, and meadowlarks. However, this ecosystem has evolved with insect disturbance for millions of years so there would be no impact to merlins over the long term.

Wildfire

Wildfire can have a wide range of potential effects on landscapes of the Black Hills, depending on size and intensity of fire, stand type, fire frequency, and post-fire successional trajectory (Buskirk 2001). In the BHNF, 2,000 – 3,100 acres are burned annually by wildfire (BHNF 1996). However, these averages have increased due to large fires that have occurred more recently. The Jasper Fire burned 83,000 acres in August 2000 and the Elk Mountain Complex Fire burnt 26,000 acres in August 2001.

Low-intensity fires in prairies are naturally occurring and common disturbances. It is a beneficial disturbance for the merlins prey as it is a rejuvenating process for herbaceous and shrub species that they depend upon. Over the long term, prairie fires maintain the prairie-forest ecotone over time by killing seedlings that are invading from the forest (Ricklefs 1993). This ecotone is important to merlins as nesting occurs there and hunting occurs in the adjacent grasslands.

In forests, wildfires could be either beneficial or detrimental to merlin populations, depending on the nature of the fire. Ponderosa pine forests in the BHNF are characterized by surface fires every five to twenty-five years (Knight 1994). These low intensity fires are thought to be beneficial to merlin by maintaining open understories and visibility. However, abnormally high fuel build-ups as a result of fire suppression have increased the probability of large, catastrophic fires that could destroy vast expanses of nesting habitat. Examples of this are the Jasper Fire and the Elk Mountain Complex Fire mentioned above. Ultimately though, the Black Hills ecosystem has evolved with wildfire and thus, impacts of wildfire to merlin viability over the long-term are likely to be negligible.

Wind Events

Wind, especially tornadoes and microbursts, is capable of altering the physical structure of forests very quickly, killing large numbers of trees (Veblen et al. 1989). However, these effects are typically small in scale and short in duration so the impacts to merlin populations over the long-term are thought to be negligible.

Other Weather Events

Other weather events that could potentially effect merlins are cold temperatures, freezing rain, heavy snowfall, and drought during the breeding season. It is possible that freezing rain and snowfall during the breeding season could cause high nestling mortality and decreased recruitment. Drought could adversely affect merlins by resulting in low production of grassland vegetation, low survivorship of prey nestlings, and thus, insufficient prey availability to produce

successful merlin nests.

SUMMARY

The Richardson's merlin is one of three subspecies of merlins present in North America. This document focuses mainly on the Richardson's merlin since it is the subspecies most common in the BHNF. The merlin is an uncommon falcon throughout most of its vast, geographical distribution. In the BHNF, it is categorized as Sensitive Species by the USFS. In South Dakota and Wyoming, the Natural Heritage Program considers the merlin secure with respect to its rangewide status although the species may be rare in parts of its range, especially at the periphery.

The merlin has a relatively short life span as individuals seldom exceed 8 years. Survivorship of adults older than one year is estimated at approximately 62%. Typically, they have high reproductive success and a clutch size between 3-5 eggs. The breeding density of merlins in nearby SE Montana was 3.8 pairs/100 km² and the home range of male merlins was 23 km². The diet of merlins consists mainly of grassland birds in the 20-40 g weight range. Hunting merlins usually select for one or two of the most abundant avian prey species. The diet also includes a small portion of small mammals, insects, and reptiles.

The merlin occurs in a variety of habitats but similar characteristics are common between occupied habitats throughout their range. Merlins rely on other birds, e.g. black-billed magpies and crows, to create a nest. Merlins can then use the nest after it has been abandoned. In the Black Hills region, merlins usually nest in abandoned black-billed magpie nests in ponderosa pine trees. Nests are located adjacent to prairie landscapes as most hunting activities occur there. Horned larks, lark buntings, and meadowlarks would presumably be the most common prey items in the BHNF.

In the BHNF, continued loss of grasslands and loss of nest sites to timber harvest are presumably the greatest risks to merlin populations. A decline of grassland habitat in the region has occurred with the conversion of prairies for agriculture and because fire suppression has resulted in trees invading into grasslands. Grasslands are an uncommon cover type within the Forest and are likely to be important to merlin viability in the area. Loss of nest sites to timber harvest is another threat.

Recreation is unlikely to have important effects on merlin viability in the BHNF. It is unlikely that livestock grazing would have important effects on merlins even though it is plausible that prey species might be impacted. It is unlikely that the proposed levels of mining on the BHNF will impact merlins. Prescribed fire could benefit merlins by killing saplings that are invading grasslands and killing understory plants that would cause abnormally high densities of vegetation in forests. Continued fire suppression in the area is likely to adversely affect merlin habitat by increasing tree density in the forests, causing high fuel build ups, and allowing trees to invade adjacent grasslands. The high fuel build ups could result in high intensity wildfires that destroy vast expanses of nesting habitat. The effects of non-native plant establishment and control in the BHNF is unknown but merlins have been observed to benefit from exotic trees species in urban parts of Canada. The effects of fuelwood harvest to merlins in the BHNF likely depends on the form and extent. Over the long term, insect disturbances and weather events are unlikely to have adverse effects to merlin viability on the BHNF as these disturbances have evolved with the

landscape for millions of years.

REVIEW OF CONSERVATION PRACTICES

Management Practices

On the BHNF, an ecosystem management approach has been used in an attempt to follow the guidelines in the National Forest Management Act. Essentially, when forest managers are managing for different uses inside the boundaries of the BHNF, they must manage for a mix of habitats across the entire Forest to provide for species diversity and viability. In the case of the merlin, the impacts of activities on the Forest to merlin viability are assessed before they occur. Other than these assessments, management activities specifically for this species by the BHNF are limited

Management practices in North America that specifically target merlin populations are rare. Monitoring of environmental contaminants in merlins has been important due to the population declines observed between the 1940s to early 1970s. Also, in Regina, Saskatchewan, a release of six captive bred merlins may have been responsible for the establishment of a current breeding populations of about 20 pairs (Sodhi et al. 1993).

Models

There are no models we are aware of that model habitat, effects, or other items of interest to merlin managers.

Survey And Inventory Approaches (Presence/Absence)

Several techniques are used to survey and inventory the presence/absence of merlins. The use of different techniques depends on the scale of the area to be inventoried. Throughout North America, the BBS (Sauer et al. 2001) and CBC (Sauer et al. 1996) are used to survey merlin presence/absence and to inventory population trends. A strength of these surveys is that data is collected throughout most of North America in an attempt to detect rangewide trends. A weakness of these surveys is the manpower required and the logistics of compiling and analyzing all the data. The CBC is less reliable than the BBS due to inconsistencies in methodology.

At a smaller scale, other techniques used to survey and inventory the presence/absence of merlins include searching historic nest sites for signs of reoccupancy and search areas with characteristics similar to nesting habitat for signs of breeding activity. Taped vocalizations can be used to enhance the detectability of merlins during these surveys. In Wyoming, Ayers and Anderson (1999) searched historic nest sites for signs of reoccupancy and searched areas with characteristics similar to that of nesting habitat for signs of breeding activity. They searched 58 historic sites an average of 2 - 3 times and 52 random sites once each for evidence of merlin breeding attempts. Taped vocalizations were used to solicit a territorial response from adults. Searches averaged 14.8 and 3.5 hours of search effort at historic sites and random sites, respectively. During the two-year study, 18 unique sites of the historic sites were reoccupied by merlins and no signs of activity were located at any of the 52 random survey sites. Searching historic nest sites was cost-effective and successful at documenting the distribution and population status of merlins in Wyoming. However, searching random sites based on

macrohabitat features with characteristics similar to merlin nest sites proved to be unsuccessful.

Monitoring Approaches (Habitat, Population Trend, Presence/Absence And Persistence)

The BBS, CBC, searching historic nest sites to monitor nest reoccupancy, and the systematized searching of new areas for signs of breeding activity are approaches used to monitor that have already been discussed above. Migration counts, banding, and radio telemetry are additional methods that can be used to monitor habitat, population trends, presence/absence and persistence. Migration counts can be effective at establishing population trends over periods of time. A limitation associated with migration counts is that multiple years of data are required before meaningful estimates of population trends can be made. Also, the counts cannot be used to assess where the birds originated so the application of the data to specific areas such the BHNF is limited. Banding is a cost-effective method for estimating survivorship and dispersal. A disadvantage of banding is that a sometimes unrealistically large number of bands are needed due to low recovery rates. Return rates from two studies were only 0.8% and $\sim 2.5\%$ (Schmutz et al. 1991, Houston and Hodson 1997). A radio-telemetry study of merlins nesting within the BHNF would be beneficial by providing home range and habitat use information during the breeding season. Habitat requirements specific to the BHNF would be the goal of such a study and would better enable managers to mitigate the impacts of other management activities to merlins. Problems associated with the technique are that radio telemetry equipment is expensive, acquisition of the data is time consuming, and merlins occur at low densities in the BHNF. Low densities of breeding merlins could result in questions about the statistical validity of data due to a small sample of telemetered birds.

ADDITIONAL INFORMATION NEEDS

Currently, management directives aimed specifically at merlins on the BHNF are limited. Initially, information on historical merlin nest sites in the Forest should be collected so that future management activities can be accurately mitigated when they occur near nest sites. Additionally, these nest sites could be monitored on a yearly basis. Information from nest monitoring would establish population trend, reoccupancy rates, recruitment rates, and habitat use information of nest sites. Ideally, nestlings would be banded so that information on merlin survival and dispersal might be collected. A radio-telemetry study of merlins nesting within the BHNF would be beneficial by providing home range and habitat use information during the breeding season. Habitat requirements specific to the BHNF would be the goal of such a study and would better enable managers to mitigate the impacts of other management activities to merlins. Finally, additional information about nest site availability may benefit managers. If nest structures limit merlins in the BHNF, artificial nest structures might increase the number of breeding merlins. No information is available concerning the effectiveness of artificial nest structures though.

Figure 1. Enviro-gram representing the web of linkages between Richardson's merlins and the ecosystem in which they occur.

	CENTRUM			
4	3	2	1	

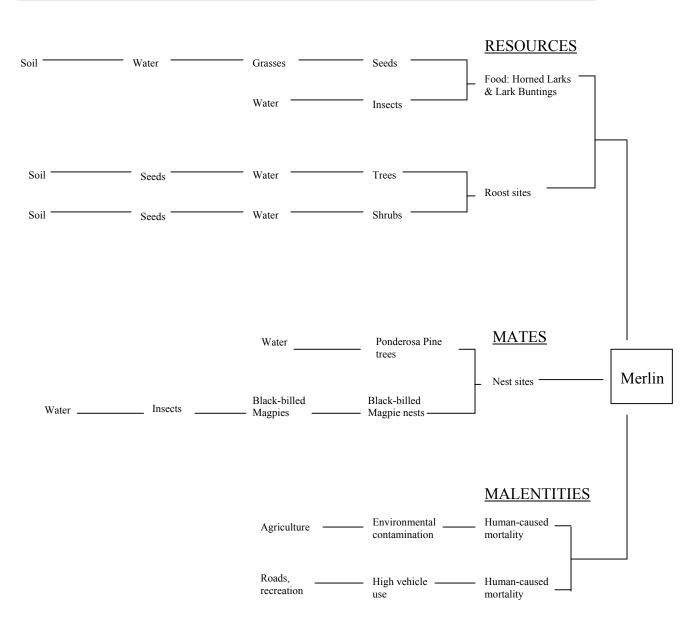
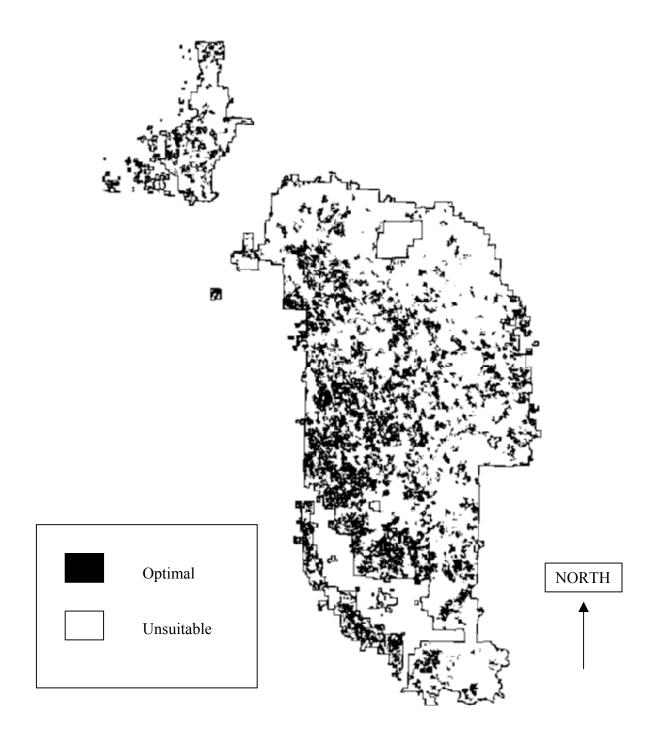


Figure 2. Black Hills National Forest Merlin Habitat 1995 (BHNF 1996)



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DEFINITIONS

Adult dispersal – distance between the previous and present year's nest site.

Immigrant males – breeding males hatched outside of the city.

Natal dispersal – movement between birth place and breeding site.

Partial migrant - some individuals staying in the breeding area while others migrate.

Resident males – breeding males hatched inside of the city.